Journal of Applied Structural Equation Modeling

eISSN: 2590-4221 *Journal of Applied Structural Equation Modeling, 7(2),1-18, June 2023*
DOI: 10.47263/JASEM.7(6)06

MODELING THE EFFECT OF HIGHER-ORDER THINKING SKILLS AND TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE ON STUDENTS' DIGITAL LITERACY

Wanda Nugroho Yanuarto[1]*, Ira Hapsari[2], and Eka Setyaningsih[1]

[1]*Faculty of Teacher Training and Education, University of Muhammadiyah Purwokerto, Indonesia*

[2]*Faculty of Economical and Business, University of Muhammadiyah, Purwokerto, Indonesia*

**wandanugrohoyanuarto@ump.ac.id*

ABSTRACT

This study aims to assess the impact of Higher-Order Thinking Skills (HOTS) and Technological Pedagogical Content Knowledge (TPCK) on Digital Literacy (DL) in the context of digital classrooms. Data were collected from 182 students, and structural equation modeling was used to test the study's hypotheses. Our findings indicate that proficiency in technology pedagogy and higher-order thinking skills enhances students' digital literacy. Specifically, DL benefits substantially from the application of HOTS. However, there is room for a stronger association between TPCK expertise and DL. Of all the model variables, HOTS makes the most significant contribution to DL. This is crucial because it enhances students' problem-solving and technological capabilities in the classroom. Therefore, mathematics education should incorporate activities that nurture original and diverse thinking, without restricting students' access to technology. In addition, TPCK is vital for technological projects that are grounded in theoretical concepts, such as technological innovation. Our study contributes to the understanding of the importance of HOTS and TPCL to foster DL practices.

Keywords: *Digital literacy, higher-order thinking skills, technological pedagogical content knowledge*

INTRODUCTION

The concept of the Fourth Industrial Revolution (IR 4.0) has gained significant attention recently, characterized by ubiquitous connectivity, AI, and an enhanced focus on machine learning. In this context, the term "Internet of Things" (IoT) refers to the pervasive nature of internet connectivity in students' daily lives. Activities such as online travel, shopping, and learning exemplify various settings that currently leverage networks connected to the IoT (Alakrash & Razak, 2021). Urakova et al. (2023) highlighted that the IoT functions as a network. Furthermore, the IoT has the potential to usher in a new learning paradigm by integrating a range of user mobility technologies with data analytics (Silva et al., 2021). This latter approach is pivotal to the ongoing debate over educational paradigm shifts enabled by widespread digital literacy.

In the classroom, digital infrastructure serves as a crucial enabler for digital literacy (DL). necessitates the capacity to read, analyze, and critically engage with a diverse array of communication channels. These include, but are not limited to, written text, spoken language, broadcast media, and digital platforms (Fedorova et al., 2021). As advancements in science and technology continue, the pedagogical tools available to educators in reading and writing have similarly evolved. The effective integration of DL into educational curricula is now considered essential for successful learning outcomes (George, 2022).

The incorporation of DL into classroom settings provides students with novel opportunities for collaboration, access to diverse resources, literacy across varied reading genres, as well as tools for independent problem-solving and reference (Lauren, 2021). Utilizing DL not only enhances students' subject-matter proficiency but also fosters their individual competitiveness and growth (Payton & Hague, 2021). Additionally, DL facilitates the rapid and efficient acquisition of new material, while concurrently promoting a critical mindset essential for discerning reliable resources.

However, not all students readily have access to online learning environments. Challenges such as language barriers and significant disparities in cognitive abilities must be surmounted for successful remote education. Both Digital Literacy (DL) and Technological Pedagogical Content Knowledge (TPCK) are critical for optimizing learning outcomes in contemporary digital classrooms (Suharyati et al., 2022). Students engaged in TPCK activities actively refine and augment their existing DL competencies, indicating that a synergistic relationship between DL and TPCK is pivotal for the success of digital classrooms (Subroto, 2021).

Concurrently, Fita et al. (2021) emphasize that in the context of pervasive technological influence and the ongoing Fourth Industrial Revolution (IR 4.0), the development of critical and creative thinking capacities is indispensable for academic success in today's educational landscape. Critical thinking is essential not only for navigating contemporary challenges but also for capitalizing on emerging opportunities. Higher-Order Thinking Skills (HOTS) empower students to engage in both analytical and creative reasoning. Achieving HOTS signifies that a student has either critically assessed acquired knowledge or innovatively applied it. Afriana et al. (2021) corroborates that student learning is enhanced when educational activities necessitate creative application of prior knowledge.

In today's educational landscape, where students are expected to exhibit both critical and creative thinking, effective guidance in the application of Higher-Order Thinking Skills (HOTS) within technological contexts is indispensable for success (Surjanti, 2022). Increased emphasis on DL and TPCK is warranted, particularly when leveraging advanced training methodologies. According to Sepriyanti et al. (2022), approximately 11.35% of students encounter challenges in expressing HOTS. This limitation stems from a sustained need for enhanced instruction in digital literacy and greater familiarity with digital concepts. Rahayu et al. (2021) noted that 16.33% of students require additional support during this educational transition, which involves the development of critical and creative thinking skills integral to HOTS.

Prior research indicates that students must take full ownership of their Digital Literacy (DL) learning to excel in online courses (Andrew, 2021; Bouzid et al., 2021; George, 2021). Furthermore, cultivating HOTS in students within online learning environments poses unique challenges (Setiyowati & Shodikin, 2022). Given these complexities, it becomes imperative to implement targeted interventions and undertake research to understand how these three factors—DL, HOTS, and TPCK—interact to address educational challenges. Therefore, the aim of this study is to examine the influence of HOTS and TPCK on DL in the context of digital classrooms. Arising from these objectives, the study seeks to answer the following research question: 1) To what extent do HOTS and TPCK impact the academic success of students in terms of DL?

LITERATURE REVIEW

Higher-order thinking skills

Students must combine what they already know with their learning to solve problems. The following groups, as identified by Pagina (2019), can be used to categorize each level. The first step is to do an analysis, which comprises breaking anything down into its component pieces to figure out how those parts fit together and how the whole thing is built. Among the many mental operations that fall under the umbrella of "analytical processes," some of the most common include differentiating, categorizing, and assigning. The next step is to evaluate or "decide per standards and norms." The process has now entered its second stage. The onus for instituting and upholding this condition rests squarely on the student's shoulders. These internal operations are "checking" and "critiquing." To conclude, make something original by combining the necessary parts. Furthermore, the three cognitive processes that make up the imaginative facet of digital learning are conceptualization, planning, and production (Putri, 2019). Student formulation is what they come up with while they strive to understand a task, while student production is what they come up with (Schlesinger & Wang, 2019). Therefore, in the unfinished research, Analytical Evaluating (AE) and Creating (CR) can serve as markers of PLT.

Technological pedagogical content knowledge

The PTPK field integrates technological, pedagogical, and conceptual knowledge to understand better how to structure, depict, and modify certain concepts, issues, and concepts in light of students' interests, technology, knowledge, and learning uses. Technological, pedagogical, and content knowledge are the three facets of expertise that makeup PTPK (Sulistyarini & Joyoatmojo, 2022). PTPK is a framework that includes the most often-held misconceptions and the most critical components (Aoibhinn, 2016). To this end, it is crucial to regularly revisit previously learned concepts and assess students' grasp of those concepts through various educationally valuable and restorative activities directly related to the management of the degree room (Saritepeci, 2022).

Meanwhile, many programs, such as Inquisit 4 Web and OSPAN (Durdu & Dag, 2017), can be used in the classroom. In addition, according to the PTPK (Shulman, 1986), a successful model will ensure that all students have a solid grasp of the subject matter. Students should have a solid grounding in the subject matter before diving into their studies. Glastone (2020) argues that students acquire domain-specific knowledge, theoretical understanding, technology fluency, and instructional skill in the opposite direction.

Digital literacy

The ability to collect, identify, access, manage, integrate, evaluate, and analyze data appropriately using digital tools and facilities to create new knowledge, communicate with others, and take positive social action is what we mean when we talk about learning digital literacy (LDM). Using technology effectively, interpreting and understanding digital content and evaluating its credibility, and developing, researching, and communicating appropriate educational tools are the three pillars of LDM in education, as outlined by Common Sense Media (Smaldino, 2011). The new concept of the LDM (Hatlevik & Arnseth, 2018) centers on computer literacy and knowledge that can be collected, accessed, and shared via networked information technology. Therefore, it is crucial for LDM in digital instruction to develop skills in finding, compiling, interpreting, and disseminating data on educational issues.

Novitasari et al. (2020) state that to become an expert in LDM, one must hone their technical knowledge, analytical prowess, communication skills, and teamwork abilities. Competence in using digital media for the mastery of social knowledge and learning, in contrast to Saleh (2019), can be defined as the presence of the requisite skills, knowledge, and attitudes. This is why we hammered home the idea that students' Technical Skills (TS), Critical Understanding (CU), Communicative Abilities (CA), and Social Relations (CC) are the four cornerstones of their Mathematical LDM.

Meanwhile, the widespread availability of modern means of communication has influenced the evolution of education in many ways, including the use of numerous digital instruments. Multiple types of educational software, including GeoGebra, PowerPoint, and Praxis, can be used to achieve LDM through various approaches (Agyei & Voogt, 2017). Increasing the time students spend on activities like PLT, PTPK, and LDM in class is a great way to stress the importance of digital learning for students.

Theoretical framework

Vygotsky proposed the concept of the Zone of Proximal Development (ZPD) (Hausfather, 1996), which is based on the PLT. Vygotsky (1999) argues that the most effective learning occurs when guided and directed by the teacher and other students in the classroom through the ZPD process. The ZPD hypothesis stresses the importance of having a teacher present during the learning process. Instructional designers and teachers can use these recommendations to focus on project-based learning tasks (PLT) (Hausfather, 1996). Vygotsky's social constructivism, backed by the ZPD, makes a valuable contribution to PLT. For this method to be effective, there must be a free flow of information among students, a well-defined curriculum, and room for pupils to express themselves creatively in their ways (Vygotsky, 1978).

PLT development for this experiment is nearly complete (Rahmawatiningrum et al., 2019). Standardization in the classroom is a possible outcome of proximal development. The consequences of pupils' LDM and PTPK on ZPD in classrooms are also worth considering. Teachers' subject-matter expertise is proportional to their ability to aid pupils in achieving their goals (Fernández-Martn et al., 2020). According to Vygotsky (1978), effective communication is one of the most critical aspects of the ZPD. He emphasized the need for communication in tracking PLT activities and fostering academic success among students. As Hausfather (1996) notes, ZPD also helps students connect with their instructors and peers through effective communication by showing them how to channel their energy where it will have the most impact.

Therefore, PTPK is also a dynamic constructivist approach, and student participation is crucial to the growth of this strategy (Lisa, 2020). To understand how technology developments affect pedagogical procedures and digital scholastic pursuits, students need familiarity with the PTPK framework (Castéra et al., 2020). PTPK incorporates the use of a wide range of technological tools.

H_1: There is a suitability construct of PLT, PTPK to LDM in classroom instructional
H_2: There is the strength of PLT effect on LDM in classroom instructional
H_3: There is the strength of the PTPK effect on LDM in classroom instructional

METHODS

Research Design

We used a statistical method and a survey design with cross-sectional sampling for this inquiry (Creswell, 2014). This layout facilitates comprehension of the topic under investigation (Memon et al., 2017). Using a quantitative cross-sectional survey improves the reliability and validity of the study as a whole (Gay, Geoffrey, & Mills, 2012).

Undergraduates studying in education and teaching took part in this research. A statistically significant cross-section of students enrolled in the second, fourth, sixth, and eighth semesters was used to compile this sample. In total, 182 students' data were analyzed by the researchers. Participants are mathematics education majors at Universitas Muhammadiyah Purwokerto, Indonesia. Selection criteria included students' gender, academic year, level of computer expertise, and home country. Sampling plans and sample size calculations can be made after identifying a target population. Researchers used a method of stratified random sampling to choose participants from the larger population.

Data Analysis and Results

The structural model models the relationship between all of the variables. The connection may be merely correlative, but it might also be causal. Byrne (2019) explains that two arrows on a single line represent a correlation, while an arrow pointing in only one direction represents an effect. Figure 1 shows the correlation between the various variables. The structural model consists of a single thing: a Confirmatory Factor Analysis (CFA) model. Structural equation modeling (SEM) can understand the relationships between variables and target construct (Kline, 2017). Using the structural model developed for this research, we can better comprehend the effects of PLT and PTPK on LDM in the classroom.

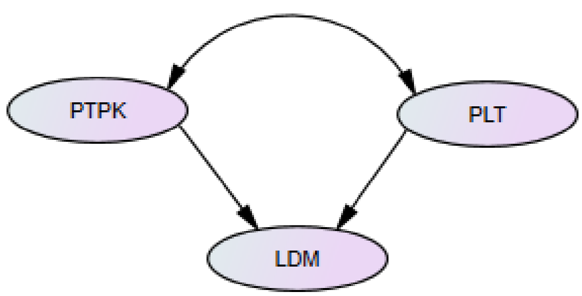

Figure 1. Research Model Study

Meanwhile, the degree of *Goodness of Fit* (GOF) can be evaluated using the tests of *Adjusted Goodness of Fit Index* (AGFI), *Goodness of Fit Index* (GFI), *Root Mean Square Error of Approximation* (RMSEA), and *Chi-Square Statistics.* A good model has a Chi-squared value that is lower than 3.0 and a p-value that is greater than 0.05; 2) the GFI and AGFI values are higher than 0.90, which indicates that the model that was developed is acceptable; and 3) the highest possible value for either the GFI or the AGFI is 1. In addition, an RMSEA value of less than 0.3 indicates that the model is close to the ideal model (Hair et al., 2014). A series of tests are performed on the model, and one of its parameters is compared to the value zero, which is a statistically significant difference at the 95% confidence interval. The SEM used in this investigation was analyzed with the help of the SEM-AMOS computer program (Byrne, 2019).

Data Instrument

The research constructs of PLT, PTPK, and LDM are utilized in this investigation. The survey used in the study was developed specifically for that purpose. Here's how the various parts of this survey are broken down: This study discusses respondent demographics, the two PLT sub-constructs (AE and CR), the seven PTPK sub-constructs (CK, PK, TK, PCK, TPK, TCK, and TPCK), and the four LDM components (TS, CU, CA, and CC). Conversely, there are just 12 items in PLT, 34 in PTPK, and 17 in LDM.

Meanwhile, the developed PLT instruments are tested to see if the final format is usable and if the learning evaluation tools have enough substance. The device will be tweaked until it's ready for testing in its current form. Yudha (2023) In our industry, PLT tools are par for the course. However, PTPK uses a distinct seven-part system. Using data from previous surveys (Destiana et al., 2022), we developed items that accurately gauge future educators' level of PTPK competence. The LDM component has been constructed into a single instrument tailored to the conditions in Indonesia by combining the results of multiple research (Abel et al., 2018; Lukitasari et al., 2022). The respondent is shown a sentence to which he or she can respond "never," "sometimes," "frequently," or "every day." An external content validity review was conducted after researchers made iterative changes and resubmitted all items. Then, they are given a digital instrument built on Google Forms, which consists of 63 questions. All three assessed constructs had high levels of internal consistency (Cronbach's PLT =.78, alpha PTPK =.88, alpha LDM =.84).

Structural Modeling

Structural Equation Models (Creswell, 2014) help investigate relationships between three or more constructs under controlled conditions. Relationships between many variables can be analyzed using structural equation modeling (SEM) (Kline, 2017). This technique can measure how well a phenomenon is connected and, by extension, its effectiveness. The purpose of the following study is to determine the relative importance of the PLT, PTPK, and LDM scores in predicting students' levels of learning achievement.

However, this research method can investigate a path structure resulting from multiple factors (Kline, 2017). The model allows us to assess the reliability of a phenomenon's associations and its level of success. The predictive power of the three crucial constructs of prior learning theory, process theory of procedural knowledge, and the learning design matrix is examined. Later in the course, when SEM is taught in a classroom context, it will look at the accuracy and consistency of the effect values that come from these three factors.

RESULTS

Respondents' information

Eighty-five students, representing 46.70% of the total, were selected from the fifth semester, seventy-one students, representing 39.01% of the total, were chosen from the third semester, and the remaining twenty-six students, representing 2.6% of the total, were collected from the seventh semester. The location of the participants in this study: 27 live in the city, while the remaining 155 are in the Village. This study determines the severity of LDM by using the demographic indicator of daily internet usage; notably, it demonstrates that most students (154 out of 182) use the internet for more than five hours daily. The results of the demographic questions are compiled in Table 1.

Table 1. Demographic Profile (N =182)

Respondent profile	Category	Frequency	Percentage (%)
Gender	Male	19	10.44
	Female	163	89.56
Semester	3rd	85	46.70
	5th	71	39.01
	7th	26	14.29
Location	City	27	14.84
	Village	155	85.16
Daily internet usage	< 3 hr	2	1.10
	3 – 5 hr	26	14.29
	> 5 hr	154	84.62

The reliability data

The *Kaiser-Meyer-Oikin* (KMO) value for the items in the PLT construct questionnaire yielded 0.854. When compared to the value of PTPK, which was calculated to be 0.749, the value of LDM was determined to be 0.875. As a result of the fact that these three values are all more than 0.50, factor analysis may be performed on the construct's components without the risk of running into significant multicollinearity concerns. *Barlett's Test of Sphericity* for the three parts returned a value of 0.000, which was statistically significant when combined with a probability level of 0.05. This illustrates that the items can be used in factor analysis without causing problems.

This study used the idea of dependability to verify that the outcomes from the surveys are consistent with one another. Because the replies were provided on a Likert scale, their reliability value (as measured by *Cronbach's alpha*) was more significant than 0.70, making them appropriate for use in this investigation.

Confirmatory factor analysis

The validity of CFA was evaluated based on the criterion for dependability established by Cronbach's Alpha. Construct the *Average Validity Estimate* (AVE) and *Composite Reliability* (CR) criteria. Each construct has a reliability rating greater than 0.7 for the Cronbach Alpha, more significant than 0.6 for the *Cronbach's Rho*, and greater than 0.5 for the AVE.

According to the findings of the CFA, PLT can be divided into two distinct subcategories. The first factor contained six subfactors, denoted by the letters LT1, LT2, LT3, LT4, and LT11. The second factor comprises six components (LT5, LT6, LT7, LT8, LT9, and LT10). The CFA analysis produced two factors to answer questions about the PLT construct: the AE and CR.

The other way, TPACK is being disassembled into seven factors. In factor one, there were five items (TP1, TP2, TP3, TP4, and TP4); in factor two, there were also four components (TP6, TP7, TP8, and TP9); and in factor three, there were five items (TP10, TP11, TP12, TP13, and TP14). The TP15, TP16, TP17, and TP18 items were counted toward factor 4, and the TP19, TP20, TP21, and TP22 items were counted toward factor 5. Five parts went into making up factor 6, and those parts were TP23, TP24, TP25, TP26, and TP27. The final component, denoted by the acronym TPACK, comprises the following sub-constructs: TP31, TP32, TP33, and TP34.

Lastly, the CFA investigation of LDM produced the following four sub-constructs: TS, CU, CA, and CC. The TS consists of three different items (LD11, 13, 17), the CU of three additional items (LD1, 2, 8), the CA of three other things (LD4, 5, 15), and the CC of five different objects (LD6, 9, 10, 14, 16).

Composite reliability (CR) criteria and *average variance extraction* (AVE) criteria use Cronbach's alpha to assess measurement model quality. The rating will be attained if the *Cronbach's Rho* (CR) and AVE values are more than 0.6 and 0.5, respectively. CR, AVE, and Cronbach Alpha values were calculated after a CFA was performed on the TD, SM, SI, PR, and PO. Table 2 shows the cutoff, average, and alpha Cronbach values used to evaluate the constructs.

Table 2. The values of CR, AVE, and Factor Loading

Constructs	**Item**	**Factor loading**	**CR**	**AVE**
Analytic Evaluation (AE)	LT1	0.770	0.673	0.645
	LT2	0.870		
	LT3	0.720		
	LT4	0.650		
	LT11	0.689		
	LT12	0.710		
Creation (CR)	LT5	0.760	0.683	0.642
	LT6	0.670		
	LT7	0.620		
	LT8	0.790		
	LT9	0.700		
	LT10	0.680		
Content Knowledge (CK)	TP6	0.380	0.783	0.632
	TP7	0.510		
	TP8	0.540		
	TP9	0.620		
Technological Knowledge (TC)	TP19	0.800	0.741	0.742
	TP20	0.870		
	TP21	0.520		
	TP22	0.580		
Pedagogical Knowledge (PK)	TP10	0.580	0.842	0.632
	TP11	0.590		
	TP12	0.560		
	TP13	0.600		
	TP14	0.650		
Technological Pedagogical Knowledge (TPK)	TP23	0.710	0.783	0.587
	TP24	0.570		
	TP25	0.520		
	TP26	0.480		
	TP27	0.620		
Technological Content Knowledge (TCK)	TP1	0.780	0.782	0.644
	TP2	0.650		
	TP3	0.780		
	TP4	0.730		
	TP5	0.530		
Pedagogical Content Knowledge (PCK)	TP15	0.490	0.842	0.642
	TP16	0.530		
	TP17	0.610		
	TP18	0.660		
Technological Pedagogical Content Knowledge (TPCK)	TP31	0.670	0.622	0.642
	TP32	0.760		
	TP33	0.810		
	TP34	0.660		

Communicative Abilities (CA)	LD4	0.440	0.748	0.689
	LD5	0.480		
	LD15	0.590		
Social Relation (CC)	LD6	0.710	0.833	0.741
	LD9	0.860		
	LD10	0.760		
	LD14	0.760		
	LD16	0.690		
Critical Understanding (CU)	LD1	0.510	0.732	0.623
	LD2	0.590		
	LD8	0.300		
Technical Skills (TS)	LD11	0.290	0.682	0.673
	LD13	0.730		
	LD17	0.590		

significant AVE>0.5; significant CR>0.6; significant at p<0.05; ***significant at p<001; AVE= Average Variance Extracted; CR= Composite Reality

There are a total of thirteen parts to this investigation, as listed in Table 3. There are six types of AE (LT1, 2, 3, 4, 11, and 12), six types of CR (LT5, 6, 7, 8, 9, and 10), four types of CK (TP6, 7, 8, and 9), and four types of TC (TP19, 20, 21, and 22). There are five TP variants available today. There are five TPs in the TPK (TP23–TP27). There are five different types of TCK, designated TP1–TP5. There are a total of four PCKs. Concurrently, there are four components of TPCK (TP31, 32, 33, and 34). So now the CA has three (LD4, LD5, and LD15). There are five components to the CC (LD6, 9, 10, 14, and 16). There are three in the CU: LD1, 2, and 8. LD11, 13, and 17 are the final three components of TS.

Structural equation model

Unidimensionality, validity, and dependability are the three pillars that support SEM. Unidimensionality is the most important. A pooled CFA must be carried out to satisfy these three requirements before a structural model analysis. It is required to ensure that the loading factor for each item and dimension is more than 0.6 to achieve unidimensionality. A CFA can be used to establish all three types of validity: convergent, construct, and discriminant. These are the types of validity that can be found. If the value of the AVE can be used to validate all of the elements in the measurement model, then the model has convergent validity. AVE stands for the average value of the component. Validity of discrimination was reached if the measurement model did not contain any items that measured the same two things, and validity in terms of the construct was attained based on the significance of the GOF. In addition, discrimination validity has been achieved if the correlation value between the two exogenous constructs is less than 0.4.

In determining which model best explains the study's findings, the analysis refers to Figure 2. To begin, we use the fit index to determine whether or not the hypothesized model is compatible with the data provided by the respondent. There must be at least one compatibility index that satisfies the prerequisites for the bare minimum inside each of the three compatibility categories. The findings of the structural equation analysis displayed in Figure 2 have a Chi-Square/df value of 2.611, less than 5.0, and a value of 0.094 for the RMSEA, less than 0.3. Both of these values are less than 0.3. The CFI, TLI, and NFI all have excellent fit indices, the CFI coming in at 0.929, the TLI at 0.911, and the NFI at 0.891. When the model is compatible with the respondent data, it is necessary to evaluate each coefficient to evaluate. Then, testing a hypothesis is regarded statistically significant if the p-value is less than 0.05, and the test itself is unidirectional because the direction of the link (a positive one) is already known.

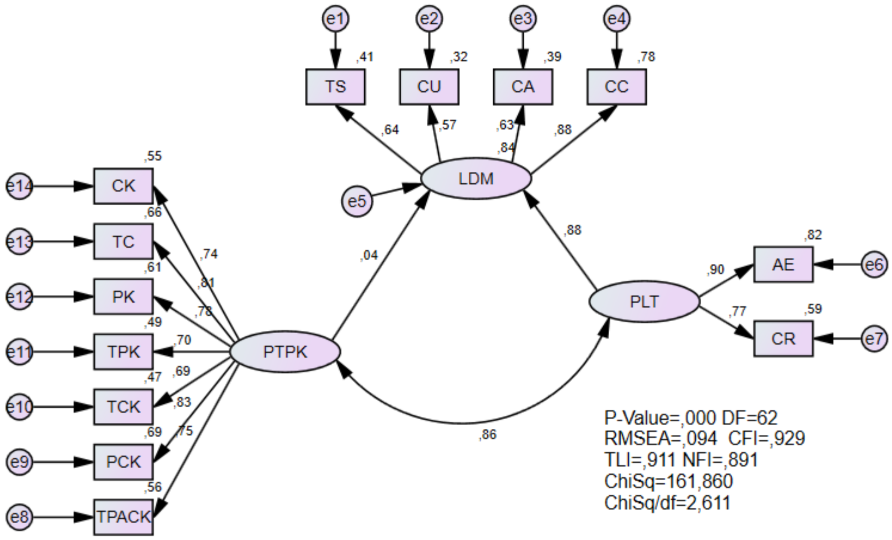

Figure 2. Structural Model

Three apparent manifestations of the factors were taken into consideration in the analysis. The coefficient, also known as the standard estimate or standard regression weight, is linked to the S*tandard Error* (SE), the *Critical Ratio* (CR), and the significant value (p) ($p< 0.001$). To test the hypothesis, p and are taken into consideration as coefficients. The term "little contribution" refers to a value that is less than 0.10, "medium contribution" refers to a value that falls between 0.10 and 0.50, and "high contribution" refers to a value that is larger than 0.50. Insignificant contribution levels include either low (less than 0.1) or negative. Therefore, even if the p-value is significant, the hypothesis will be rejected if it is smaller than 0.10 and negative. This is true even if the p-value is significant. A result is considered statistically significant if the p-value is less than 0.05. Figure 5 demonstrates that the link between PTPK and PLT is exceptionally substantial. This is the same conclusion that can be drawn regarding the connection between PLT and LDM (β= 0.88). The association between PTPK and LDM is somewhat minimal (β = 0.04) even though the two are related. Therefore, all of the data from the correlations between the three constructs are given in Table 3.

Table 3. Results of Structural Model

Constructs effect	β	AVE	CR	p value	Decision
LDM ← PLT	-0.224	0.197	-3.598	***	not significant
LDM ← PTPK	1.630	3.994	3.081	0.002	significant
TS ← LDM	0.246	0.421	1.342	0.001	significant
CU ← LDM	0.963	1.124	4.564	0.001	significant
CA ← LDM	0.206	0.300	2.995	0.003	significant
CC ← LDM	0.712	2.420	2.421	0.024	significant
AE ← PLT	0.074	0.064	1.909	0.056	no significant
CR ← PLT	0.120	0.492	2.430	***	significant
CK ← PTPK	-0.019	0.290	-0.498	0.618	no significant
TC ← PTPK	0.164	0.543	2.529	0.011	significant
PK ← PTPK	0.148	0.627	2.434	0.015	significant

TPK ← PTPK	0.789	2.694	3.099	0.002	significant
TCK ← PTPK	0.760	2.620	3.097	0.002	significant
PCK ← PTPK	0.257	3.982	2.409	0.042	significant
TPCK ← PTPK	0.330	0.422	3.915	***	significant

Significant at β positive; significant AVE>0.5; significant CR>0.6; significant at $p<0.05$; ***significant at $p<001$; AVE= Average Variance Extracted; CR= Composite Reality.

Table 5 shows no statistically significant correlation between PTPK and CK (β=-0.019; negative; SE = 0.290; CR = -0.498; p = 0.000; p 0.001). PTPK is significantly impacted by the remaining constructions as well. TC (β=0.164, SE = 0.543, CR = 2.529, p = 0.011, p<0.001), PK (β=0.148, SE = 0.627, CR = 2.434, p = 0.015, p<0.05), TPK (β=0.789, SE = 2.694, CR = 3.099, p = 0.002; p<0.05), TCK (β=0.760, SE = 2.620, CR = 3.097, p = 0.002; p< 0.05), PCK (β=0.257, SE = 3.982, CR = 2.409, p = 0.042; p< 0.05) and TPCK (β=0.330, SE = 0.422, CR = 3.915, p = 0.000; p< 0.001).

Furthermore, while there was a correlation between PLT and AE, it was not statistically significant (β=0.074, SE = 0.064, CR = 1.909, p = 0.056; p> 0.05), there was a substantial correlation between PLT and CR (β=0.120, SE = 0.492, AE = 2.430, p = 0.000; p<0.001). Although all relationships inside an LDM are important. TS (β=0.246, SE = 0.421, CR = 1.342, p = 0.001; p<0.05), CU (β=0.963, SE = 1.124, p = 0.001; p 0.05), CA (β= 0.206, SE = 0.300, p = 0.003; p<0.05), and CC (β=0.712, SE = 2.420, p = 0.024; p<0.05).

DISCUSSION

This study's findings suggest that intrinsic motivation is critical to successful teaching. According to Harold (2021), many strategies have been used to address problems resulting from pupils' technology worldviews. Many researchers have referred to this point of view as the PLT with the function of technology in education (Bruce, 2022; Leticia et al., 2023; Singh Malik, 2021). Therefore, many educators think pupils' technological skills should be prioritized. Darwin (2023) contends that improving technological literacy is the key to solving LDM literacy problems. Furthermore, Beogard (2021) discovered that making educators more aware of the importance of technology in everyday life can lead to a greater awareness of the usefulness of technology and digital literacy. To boost students' LDM, teachers must change how students view technology's role in the classroom. Learning Design Maturity (LDM) can be fostered by teachers who recognize the value of technology in the school (Erdem, 2020).

Subsequently, a favorable view of technology in the classroom is crucial for keeping students' LDM (Lapek, 2020). Students can gain more comfort with the school's use of technology in the classroom by participating in skill-building seminars (Sarah, 2023). The hope is that this will give students a framework for understanding the classroom data they collect and analyze. Students learn to trust themselves as they apply the technological skills and knowledge they have acquired to real-world tasks. Thanks to the progress made in IT, educators are doing everything possible to boost their pupils' chances of success. In addition, Mawas and Muntean (2023) found that students who had previously accomplished challenging technological goals were more likely to use technology effectively in the classroom to aid learning and evaluate progress with predetermined standards.

Previous research has shown the pros and cons of incorporating technological tools into classrooms. Based on the findings of studies (Ghavifekr & Athirah, 2017; Toha Tohara et al., 2021), the vast majority of educators understand the value of introducing concepts of digital literacy to their students and are appreciative of the ease with which they can now access resources that are relevant to their teaching. As argued by Hatlevik and Arnseth (2018), the multiple benefits of digital literacy also provide teachers with benefits that can be used in the classroom. The topic's appeal, ease of use, multimodality, relevance, engagement, and significance are just a few of these benefits. Teachers should be equipped to bring digital literacy benefits into the classroom appropriately. However, the success of integrating technology into the classroom is equally dependent on instructors' degrees of TPACK. Success in implementing digital integration is linked to teachers' level of technical literacy (Talib et al., 2016).

The results demonstrate that PLT does have a significant impact on LDM. According to this research, digital learning environments are rapidly becoming the principal means through which individuals acquire knowledge that may be used in formal education (Afriana et al., 2021). The sentence could be interpreted as representing the student learned in class and through independent study using online resources. Therefore, it is crucial to back training exercises to maintain and further enhance PLT. Schlesinger and Wang (2019) observed that learners were excited about the pilot program and found the subsequent helpful feedback in improving their training; our study validates those findings. This study's findings that students can enhance their knowledge and abilities through professional development are consistent with those of Supriatna and Winarti (2022). Furthermore, they may have gained various skills through LDM that will allow them to present more effective lectures.

Meanwhile, the research shows that private Indonesian institutions hesitate to embrace and implement educational technology innovations. A wide variety of digital resources is available, from apps to computers to online courses. However, the findings indicate that PTPK teaching may continually be improved. The inefficiency of the current instructional design and the numerous interruptions that disrupt lessons are additional issues teachers must deal with. There was a noticeable increase in student participation and enhanced teamwork and accessibility after LDM was used in the classroom.

IMPLICATIONS

This research shows that the quality of undergraduates' digital classroom learning is significantly affected by their PLT and PTPK, which has important implications for learning design and management (LDM). When a teacher employs technological tools, pupils have more freedom to learn quickly and improve in areas where they need it the most. And they have the tools at their disposal, thanks to classroom technology, to do so. Incorporating technology into classroom instruction has been shown to improve student learning outcomes. This is because students now have a better time and have more fun in class. Students fluent in the digital sphere are more self-sufficient and willing to explore uncharted areas than their forebears. Teachers must improvise and reconsider their responsibilities since they are not the sole authority figure in the classroom. Teachers are more energized and inspired than ever, thanks to the potential for greater autonomy and creativity made possible by technological innovations in the school.

When the answers are found, the LDM can be used to get more students involved by letting them ask their most essential issues in a discussion board or by email. Once the respondents have been identified, this can be done. The LDM also facilitated better instructor-student communication. The results showed that when students used the online tools, they were better prepared for in-person meetings with their instructors. Some respondents also pointed to a need for more software and hardware support for teachers as a cause of the issue with instructional design and the challenge of finding sufficient resources. So they had to deal with interruptions from their slow internet connections and plagiarism from students who just copied and pasted the answers and thoughts of their classmates.

Students' use of various LDMs was also crucial in fostering an environment conducive to teamwork. Group projects are an excellent opportunity for students to practice using PLT's emphasis on open communication and sharing PTPK perspectives. As a result, LDM allowed educators and students to personalize lessons based on factors such as students' Prior Learning Targets and their proximity to PTPK sites.

Theoretical Contribution

Since Vygotsky's theory suggests that students' brains store information for later use in learning, a ZPD was established using PLT. Vygotsky contends that the ZPD process, in which students supervise and direct their knowledge, is essential to the effectiveness of education. ZPD development stresses the importance of using such "tools" as guides or manuals when studying new processes or concepts. It's a step in the right direction for student-centered (constructivist) teaching and progressive learning. By emphasizing the role of technology and conversation, Vygotsky's theory leads to ZPD. He maintains that communication guides the instructor and facilitates object manipulation. Students in the modern era have more chances than ever to make genuine connections, all because of technology developments. We can now appreciate how LDM and PTPK may enhance communication thanks to technology's vital role in the classroom.

The model in this research is helpful since it uses indicators to represent each topic. Using these measures, teachers may zero in on the areas where their students need the most help. For instance, this research has implications for teachers who want to give the LDM aspect of edtech improvement a higher priority. Furthermore, PTPK should prompt students to evaluate the value of technology in the classroom. If they want their students to acquire PTPK knowledge and abilities, educators should be familiar with the content, technology, and pedagogy concepts of PLT. All ideas, whether pedagogical, technological, or related to the topic at hand, are treated equally in this PLT.

Practical Contribution

According to the findings, PLT makes the most outstanding contribution to LDM of all model variables. This factor is the most important since it improves students' problem-solving and technological skills in the classroom. Therefore, mathematics education should contain activities that foster original, diverse thought without limiting students' access to technology. Examples of effective pedagogical practises include group work, brainstorming, and design projects in the classroom. In this approach, students are pushed to the limits of their skills and knowledge as they share and debate original concepts.

The significance of PTPK in establishing LDM is also emphasized. In addition to its importance in the classroom, knowledge of PTPK is crucial for technological endeavors that rely on theoretical concepts, such as technological innovation. Twenty-first-century pedagogical strategies, such as complex problem solving, can gain from a greater emphasis on PTPK. Understanding the problem's complexity and the availability of relevant information are prerequisites for arriving at a workable solution.

The data indicated that PTPK played a minor role in the development of LDM. This conclusion has implications for the development of PTPK among students, particularly in education, as it suggests that more students should participate in programs that aim to help them recognize and develop their PTPK. Technology-based club activities, technological innovations, educational camps, exhibitions and demonstrations, and instructional programs are frequently adopted. This is because participating in such a program is an excellent method for students to hone their PTPK abilities, learn about different approaches, widen their horizons, and realize their full potential in technology.

CONCLUSION

The PLT, PTPK, and LDM are cornerstones that must form the foundation of every digital education program. Teachers must adapt to and embrace new technology to ensure that PTPK, PLT, and LDM remain cornerstones of education. This aligns with the efforts to reform a highly effective and efficient educational system. This study's findings shed light on where PLT, PTPK, and LDM stand in today's schools. It can add to the current topic of whether or not incorporating more PLT, PTPK, and LDM into higher education efficiently improves students' learning abilities. To fully benefit from the aspects that influence learning effectiveness in today's technological world, further research is required to obtain the most recent discoveries in this subject. This will also help one comprehend the cutting edge of this area of study. To prepare students for the ever-increasing complexities of scientific research and technological growth, education has evolved in unison with the needs of modern society. Similar to the rapid pace of scientific and technological development, the education sector must adapt. Teachers here are expected to expand their repertoire of teaching strategies constantly.

Limitations and Future Recommendations

This research focuses solely on first-year students at Universitas Muhammadiyah Purwokerto in Indonesia. That would be the study's caveats. Given this, studies can be expanded to include a broader range of participants, such as students of different ages and majors from institutions like the School of Social Sciences. However, one independent variable that was not examined was students' levels of anxiousness during learning. Since the components (PLT, LDM, and PTPK) investigated in this study account for 88% of the variance in LDM between students, it may be the subject of future research. The remaining 13% can be attributed to other aspects of this investigation.

REFERENCES

Abel, T., Brazas, J., Jr, D. C., & Kemp, A. (2018). Characterizing Mathematical Digital Literacy: A Preiminary Investigation. *Journal of Curriculum and Instruction*, *4*(2), 421–430.

Afriana, N., Halim, A., & Syukri, M. (2021). Analysis of the Characteristics of Students' Critical Thinking Skills in Completing National Exam Questions. *Jurnal Penelitian Pendidikan IPA*, *7*(2), 196. https://doi.org/10.29303/jppipa.v7i2.627

Agyei, D. D., & Voogt, J. (2017). ICT use in the teaching of mathematics: Implications for professional development of pre-service teachers in Ghana. *Education and Information Technologies*, *16*(4), 423–439. https://doi.org/10.1007/s10639-010-9141-9

Alakrash, H. M., & Razak, N. A. (2021). Education and the fourth industrial revolution: Lessons from COVID-19. *Computers, Materials and Continua*, *70*(1), 951–962. https://doi.org/10.32604/cmc.2022.014288

Memon, M., Cheah, J.-H., Ramayah Hiram Ting, T., & Chuah, F. (2017). Mediation Analysis Issues and Recommendations. *Journal of Applied Structural Equation Modeling*, *2*(1), 2590–4221.

Andrew, L. (2021). Digital skills Rethinking education and training in the digital age: Digital skills and new models for learning. *Educational Review and Learning*, *9*(2), 90–111.

Aoibhinn, N. S. (2016). Developing Mathematics Teachers' Pedagogical Content Knowledge in Lesson Study. *International Journal for Lesson and Learning Studies*, *5*(3), 212–226.

Beogard, G. (2021). A list of Skills for The 21st Century. *Journal of Educational Studies and Technology*, *45*(2), 45–61.

Bouzid, T., Kaddari, F., Darhmaoui, H., & Bouzid, E. G. (2021). Enhancing math-class experience throughout digital game-based learning, the case of moroccan elementary public schools. *International Journal of Modern Education and Computer Science*, *13*(5), 1–13. https://doi.org/10.5815/ijmecs.2021.05.01

Bruce, K. (2022). Improving competences for the 21st Century: An Agenda for European Cooperation on Schools. *Journal of Education and Learning Studies*, *54*(2), 52–69.

Byrne, B. M. (2019). Structural Equation Modeling with Amos: Basic Concepts, Applications and Programming. *Journal of Applied Quantitative Methods*, *5*(2), 365–367.

Castéra, J., Marre, C. C., Chan, M., Yok, K., Impedovo, M. A. A., Sarapuu, T., Castéra, J., Marre, C. C., Chan, M., Yok, K., Sherab, K., A, M. A., Castéra, J., Marre, C. C., Chan, M., Yok, K., Sherab, K., & Antonietta, M. (2020). Self-reported TPACK of teacher educators across six countries in Asia and Europe. *Education and Information Technologies*, *25*(1), 3003–3019.

Creswell, J. W. (2014). Research Design: Qualitative, Quantitative, and Mixed Method. In *Research design Qualitative quantitative and mixed methods approaches.* https://doi.org/10.1007/s13398-014-0173-7.2

Darwin, E. (2023). Teaching 21st-Century Skills in the Classroom: How to Include Transferable Skills in Education. *American Studies in Education and Learning*, *21*(5), 42–59.

Destiana, B., Priyanto, P., Walipranoto, P., & Irfan, R. (2022). Development and Validation of a TPACK Instrument for Preservice Teachers in the Faculty of Engineering UNY. *Elinvo (Electronics, Informatics, and Vocational Education)*, *6*(2), 183–193. https://doi.org/10.21831/elinvo.v6i2.44301

Durdu, L., & Dag, F. (2017). Pre-Service Teachers' TPACK Development and Conceptions through a TPACK-Based Course. *Australian Journal of Teacher Education*, *42*(11), 150–171. https://doi.org/10.14221/ajte.2017v42n11.10

Erdem, C. (2020). Introduction to 21st Century Skills and Education. *Journal of Learning and Education*, *25*(1), 44–69.

Fedorova, E. N., Berezina, T. I., Moskalenko, M. S., Tukshumskaya, A. V., & Timokhina, Y. Y. (2021). Digital Teacher for the 21 st -century School 4.0 . *SHS Web of Conferences*, *121*, 02015. https://doi.org/10.1051/shsconf/202112102015

Fernández-Martín, F. D., Romero-Rodríguez, J. M., Gómez-García, G., & Navas-Parejo, M. R. (2020). Impact of the flipped classroom method in the mathematical area: A systematic review. *Mathematics Education Research Journal*, *8*(12), 1–11. https://doi.org/10.3390/math8122162

Fita, M. N., Jatmiko, B., & Sudibyo, E. (2021). The Effectiveness of Problem Based Learning (PBL) Based Socioscientific Issue (SSI) to Improve Critical Thinking Skills. *Studies in Learning and Teaching*, *2*(3), 1–9. https://doi.org/10.46627/silet.v2i3.71

George, J. (2021). Digital Skills For Our Digital Future. *Journal for Educational Learning*, *21*(5), 553–569.

George, Y. (2022). Catalysing Education 4.0 Investing in the Future of Learning for a Human. *Journal of Management Educational Learning*, *42*(4), 88–111.

Ghavifekr, S., & Athirah, W. (2017). Teaching and Learning with Technology : Effectiveness of ICT Integration in Schools. *International Journal of Research*, *6*(4), 200–208.

Glastone, B. (2020). Role of Technology Learning in TPACK Level. *Journal of Digital Learning in Teacher Education*, *4*(3), 44–58.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). Multivariate Data Analysis. In *Pearson Education Limited.*

Harold, M. (2021). 21st Century Skills Digital Literacies for a Digital Age. *Journal of Education and Technology*, *23*(4), 33–46.

Hatlevik, O. E., & Arnseth, H. C. (2018). ICT, teaching and leadership: How do teachers experience the importance of ICT-supportive school leaders? *Nordic Journal of Digital Literacy*, *2*(1), 55–69.

Hausfather, S. J. (1996). Vygotsky and Schooling: Creating a Social Context for Learning. *Action in Teacher Education*, *18*(2), 1–10. https://doi.org/10.1080/01626620.1996.10462828

Gay, Geoffrey E. Mills, P. W. A. (2012). *Educational Research: Competencies for Analysis and Applications.* New York: Routledge.

Kline, R. B. (2017). Principles and Practice of Structural Equation Modeling. *Journal Basic of Education*, *3*(21), 445–458.

Lapek, J. (2020). Promoting 21 st Century Skills in Problem-Based Learning Environments. *Journal of Educational Learning and Management System*, *44*(2), 44–61.

Lauren, B. (2021). Strengthening Digital Learning across Indonesia: A Study Brief. *Journal of Educational Learning*, *4*(2), 44–58.

Leticia, M., Cusanelli, N., & Trevallion, D. (2023). Using Technology for Productive, Creative Purpose. *International Journal of Innovation, Creativity and Change. Www.Ijicc.Net*, *13*(1), 20–38.

Lisa, M. (2020). TPACK Level and Students Construction in Mathematics Learning during Covid-19 Pandemic Situation. *Journal of Education and E-Learning*, *4*(3), 221–235.

Lukitasari, M., Murtafiah, W., Ramdiah, S., Hasan, R., & Sukri, A. (2022). Constructing Digital Literacy Instrument and its Effect on College Students' Learning Outcomes. *International Journal of Instruction*, *15*(2), 171–188. https://doi.org/10.29333/iji.2022.15210a

Mawas, N. El, & Muntean, C. H. (2023). Supporting Lifelong Learning Through Development of 21st Century Skills. *Education and Learning Theory*, *24*(2), 445–458.

Novitasari, M., Sutama, Narimo, S., Fathoni, A., Rahmawati, L., & Widyasari, C. (2020). Habituation of digital literacy and critical thinking in mathematics in elementary school. *International Journal of Scientific and Technology Research*, *9*(3), 3395–3399.

Oliveira, K. K. de S., & de Souza, R. A. C. (2021). Digital Transformation towards Education 4.0. *Informatics in Education*, *3*(5), 4–16. https://doi.org/10.15388/infedu.2022.13

Pagina Thomson. (2019). Higher order thinking skills in mathematics learning. *Journal of Advanced Research Design*, *15*(2), 1. https://doi.org/http://www.jstor.org/stable/1175860

Payton, S., & Hague, C. (2021). Digital literacy across the curriculum a Future. *Journal of Education Learning and Teaching*, *4*(2), 43–58. www.futurelab.org.uk/

Putri, S. (2019). Higher Order Thinking Skills (HOTS) in Teachers' Selection of Exercise Books in SMAN 2 Sidoarjo. *Journal of Advanced Research Design*, *4*(2), 53–67.

Rahayu, S., Ladamay, I., Wiyono, B. B., Susanti, R. H., & Purwito, N. R. (2021). Electronics Student Worksheet Based on Higher Order Thinking Skills for Grade IV Elementary School. *International Journal of Elementary Education*, *5*(3), 453–460.

Rahmawatiningrum, A., Kusmayadi, T. A., & Fitriana, L. (2019). Student's ability in solving higher order thinking skills (HOTS) mathematics problem based on learning achievement. *Journal of Physics: Conference Series*, *1318*(1), 1–8. https://doi.org/10.1088/1742-6596/1318/1/012090

Saleh, B. (2019). Information and Communication Technology (ICT) Literacy of Community in Mamminasata Region. *Jurnal Pekommas*, *18*(3), 151–160.

Sarah, M. (2023). The Skills Revolution and the Future of Learning and Earning. *Journal of Education Learning*, *4*(4), 189–201.

Saritepeci, M. (2022). Modelling the Effect of TPACK and Computational Thinking on Classroom Management in Technology Enriched Courses. *Technology, Knowledge and Learning*, *27*(4), 1155–1169. https://doi.org/10.1007/s10758-021-09529-y

Schlesinger, Z., & Wang, W. I. (2019). Higher Order Thinking Skills and The Evolution of Learning Technology in The 21 Century. *Journal for Research in Mathematics Education*, *4*(3), 15–28. https://doi.org/10.1007/978-3-540-92784-6

Schmidt, D. A., Thompson, A. D., Koehler, M. J., & Shin, T. S. (2009). Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. *Journal of Research on Technology in Education*, *42*(2), 123–149.

Sepriyanti, N., Nelwati, S., Kustati, M., & Afriadi, J. (2022). the Effect of 21St-Century Learning on Higher-Order Thinking Skills (HOTS) and Numerical Literacy of Science Students in Indonesia Based on Gender. *Jurnal Pendidikan IPA Indonesia*, *11*(2), 314–321. https://doi.org/10.15294/jpii.v11i2.36384

Setiyowati, Y., & Shodikin, A. (2022). Analysis of Students Critical Thinking Ability in Solving HOTS (Higher-Order Thinking Skills) Problems with Creative Problem-Solving Model. *Jurnal Inovasi Pendidikan Dan Pembelajaran Matematika*, *8*(1), 13–20.

Shulman, L. E. E. S. (1986). Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher*, *15*(2), 4–14.

Silva, D., Lopes, T., Sobrinho, M., & Valentim, N. (2021). Investigating Initiatives to Promote the Advancement of Education 4.0: A Systematic Mapping Study. *Journal of Applied Quantitative Methods*, *1*(4), 458–466. https://doi.org/10.5220/0010439704580466

Singh Malik, R. (2021). Educational Challenges in 21st Century and Sustainable Development. *Journal of Educational Research*, *2*(1), 9–20.

Smaldino, S. E. (2011). Preparing Students with 21st Century ICT Literacy in Math and Science Education. *Journal of Curriculum and Instruction*, *5*(1), 1–3. https://doi.org/10.3776/joci.2011.v5n1p1-3

Subroto, M. (2021). Joint Effort to Promote Digital Literacy from School. *Journal of Educational Technology*, *2*(4), 553–568. https://doi.org/10.46807/aspirasi.v13i2.3391

Suharyat, Y., Santosa, T. A., Yulianti, S., & Amalia, K. N. (2022). Literature Review : TPACK-Based Science Learning in Supporting Teacher Quality in Indonesia. *International Journal of Education and Literature (IJEL)*, *1*(2), 2014–2020.

Sulistyarini, O. E., & Joyoatmojo, S. (2022). Understanding A Review Correlations between TPACK of Teacher towards Learning and Innovation Skills of Students. *International Journal of Multicultural and Multireligious*, *4*(14), 507–516.

Supriatna, N., & Winarti, M. (2022). Enhancing Higher Order Thinking Skills through Utilization of Technology in Social Studies. *SHS Web of Conference*, *01018*(149), 11–15.

Surjanti, P. (2022). Development of High Order Thinking Skills in Indonesian Teachers. *The Education and Science Journal*, *24*(3), 104–125. https://doi.org/10.17853/1994-5639-2022-3-104-125

Tabachnick, B & Fidell, L. (2014). Using Multivariate Statistics. In *Person Education Limited*.

Talib, N., Yassin, S. F. M., Nasir, M. K. M., & Bunyamin, M. A. H. (2016). Integrating Technological Pedagogical and Content Knowledge in Computer Programming Courses : Issues and Challenges. *Journal of Advanced Research Design*, *27*(1), 1–15.

Toha Tohara, A. J., Mohamed Shuhidan, Shamila Saiful Bahry, F. D., & Nordin, M. N. (2021). Exploring Digital Literacy Strategies for Students with Special Educational Needs in the Digital Age. *Turkish Journal of Computer and Mathematics Education*, *12*(9), 3345–3358.

Urakova, F. K., Ishmuradova, I. I., Kondakchian, N. A., Akhmadieva, R. S., Torkunova, J. V., Meshkova, I. N., & Mashkin, N. A. (2023). Investigating digital skills among Russian higher education students. *Contemporary Educational Technology*, *15*(1). https://doi.org/10.30935/cedtech/12600

Vygotsky, L. (1978). Mastery of Memory and Thinking. *Mind in Society*, 38–51. https://doi.org/(Original manuscripts [ca. 1930-1934])

Vygotsky, L. S. (1999). Vygotsky 's Sociocultural Theory. *Development of Higher Psychological Processes*, *3*(4), 269–279. https://doi.org/10.1007/978-94-007-4065-5

Wijnen, F., Molen, J. W. Van Der, & Voogt, J. (2021). Primary school teachers ' attitudes toward technology use and stimulating higher-order thinking in students : a review of the literature. *Journal of Research on Technology in Education*, *3*(4), 11–23. https://doi.org/10.1080/15391523.2021.1991864

Yudha, R. P. (2023). Higher Order Thinking Skills (HOTS) Test Instrument: Validity and Reliability Analysis with The Rasch Model. *Eduma : Mathematics Education Learning and Teaching*, *12*(1), 21. https://doi.org/10.24235/eduma.v12i1.9468